

WHAT IS CLAIMED IS:

1 1. A method of detecting the presence of mixed venous and arterial blood
2 pulsation in tissue, comprising:
3 receiving first and second electromagnetic radiation signals from a blood
4 perfused tissue portion corresponding to infrared and red wavelengths of light;
5 obtaining a measure of a phase difference between said first and second
6 electromagnetic radiation signals;
7 comparing said measure with a threshold value to form a comparison; and
8 detecting the presence or absence of venous pulsation using said comparison.

1 2. The method of claim 1 further comprising filtering said first and
2 second electromagnetic radiation signals before said obtaining said measure, to pass portions
3 of said first and second electromagnetic radiation signals having frequencies at or near the
4 pulse rate or harmonics of the pulse rate of said blood perfused tissue.

1 3. The method of claim 1 wherein said obtaining a measure of a phase
2 difference between said first and second electromagnetic radiation signals comprises
3 obtaining a measure of a persistent phase difference between said first and second
4 electromagnetic radiation signals.

1 4. The method of claim 3 wherein said obtaining a measure of a persistent
2 phase difference comprises integrating said measure of a phase difference over a time period.

1 5. The method of claim 1 wherein said obtaining a measure of a phase
2 difference comprises obtaining a measure of the openness of an ellipse on a Lissajous plot
3 formed by comparing the first electromagnetic radiation signal against the second
4 electromagnetic radiation signal.

1 6. The method of claim 1 wherein said obtaining a measure of a phase
2 difference comprises analyzing a cross-correlation function of said first and second
3 electromagnetic radiation signals, as a function of a delay interval between them.

1 7. The method of claim 1 wherein said obtaining a measure of a phase
2 difference comprises a frequency domain analysis and subtracting the phases of said first and
3 second electromagnetic radiation signals at a frequency.

8. The method of claim 7 wherein said subtracting the phases of said first and second electromagnetic radiation signals comprises taking the complex conjugate of said first and second electromagnetic radiation signals, and dividing said complex conjugate by the product of the magnitudes of said first and second electromagnetic radiation signals.

9. The method of claim 1 wherein said obtaining a measure of a phase difference comprises obtaining said measure of a phase difference at or near a fundamental pulse rate of said blood perfused tissue.

10. The method of claim 1 wherein said obtaining a measure of a phase difference comprises obtaining said measure of a phase difference at or near a harmonic of a pulse rate of said blood perfused tissue.

11. The method of claim 1 wherein said obtaining a measure of a phase difference comprises obtaining said measure of a phase difference at or near a fundamental or at or near a harmonic of a pulse rate of said blood perfused tissue.

12. The method of claim 1 further comprising providing a notification of the presence of venous pulsation.

13. A device for detecting the presence of mixed venous and arterial blood pulsation in tissue, comprising:

means for receiving first and second electromagnetic radiation signals from a blood perfused tissue portion corresponding to infrared and red wavelengths of light;

means for obtaining a measure of a phase difference between said first and second electromagnetic radiation signals;

means for comparing said measure with a threshold value to form a comparison; and

means for detecting the presence or absence of venous pulsation using said comparison.

14. The device of claim 13 further comprising a filter configured for filtering said first and second electromagnetic radiation signals before obtaining said measure, to pass portions of said first and second electromagnetic radiation signals having

4 frequencies at or near the pulse rate or harmonics of the pulse rate of said blood perfused
5 tissue.

1 15. The device of claim 13 wherein said means for obtaining a measure of
2 a phase difference between said first and second electromagnetic radiation signals are
3 configured for obtaining a measure of a persistent phase difference between said first and
4 second electromagnetic radiation signals.

1 16. The device of claim 15 wherein said means for obtaining a measure of
2 a persistent phase difference comprises means for integrating said measure of a phase
3 difference over a time period.

1 17. The device of claim 13 wherein said means for obtaining a measure of
2 a phase difference is configured for obtaining a measure of the openness of an ellipse on a
3 Lissajous plot formed by comparing the first electromagnetic radiation signal against the
4 second electromagnetic radiation signal.

1 18. The device of claim 13 wherein said means for obtaining a measure of
2 a phase difference is configured for analyzing a cross-correlation function of said first and
3 second electromagnetic radiation signals, as a function of a delay interval between them.

1 19. The device of claim 13 wherein said means for obtaining a measure of
2 a phase difference is configured for a frequency domain analysis and for subtracting the
3 phases of said first and second electromagnetic radiation signals at a frequency.

1 20. The device of claim 19 wherein said means for subtracting the phases
2 of said first and second electromagnetic radiation signals is configured for taking the complex
3 conjugate of said first and second electromagnetic radiation signals, and dividing said
4 complex conjugate by the product of the magnitudes of said first and second electromagnetic
5 radiation signals.

1 21. The device of claim 13 wherein said means for obtaining a measure of
2 a phase difference is configured for obtaining said measure of a phase difference at or near a
3 fundamental or at or near a harmonic of a pulse rate of said blood perfused tissue.

1 22. The device of claim 13 further comprising means for providing a
2 notification of the presence of venous pulsation.